STANDARDISATION AND NUTRITONAL EVALUATION OF MINOR MILLET BASED INSTANT UPMA MIXES

Abstract:

Dry mixes of several traditional Indian foods have gained worldwide popularity. Upma is one of the famous breakfast items of the southern India,usually prepared from wheat semolina.Minor millets are group of underutilised cereal crop with high nutritional and phytonutrient properties. The present investigation used three differently treated (soaking-drying, autoclaving-drying and roasting) four minor millets such as Proso, barnyard, little, and kodo millets for the development for instant ready to cook upma mixes to select the best treatment for sensory acceptability of each millet-based instant upmamix.Based on the sensory roasted minor millet based instant upma mixes were selected for the further study. The nutritional quality of developed instant upmamixes showed that they were good source of protein (6.26-10.68%), ash (3.37-4.27%), iron (7.32-11.28mg/100g), zinc (3.65-5.73mg/100g) and phytonutrients like phenols (1.98-6.07mg GAE/100g) and tannins (0.45-0.58mg TAE/100g). The results of the study found that instant upma mixes can be stored upto 90 days at ambient conditions in LDPE pouches.

Key words: Instant upma mix, minor millets, shelf life, phytonutrients

INTRODUCTION:

The word 'Instant Food Mix' means the process where in all the required ingredients are pre-processed and mixed, which imparts convenience to the consumers by reducing little or major processing or cooking before consumption. Additionally, they also reduce time and energy by eliminating several steps of coking (Ransumithila and Saravanakumar, 2019; Rodgeet al., 2018).In the recent years there is an increased consumption of ready to eat and instant mixes due to rapid urbanisation, industrialisation, changes in life style, food habits, culture and the phenomenon of working women. Currently, several traditional Indian foods are available as instant form in the market such as Instant Idli Mix, instant vada mix, Instant Kheer Mix, Instant Upma Mix, Instant Dhokla Mix. Majority of these instant mixes were prepared from wheat and rice. Whereas other food grains like millets especially minor millets are underutilised because of lack of technologyor inherent shortcomings (Balasubramanianet al., 2012; Rodgeet al., 2018).

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Upma is one of the famous breakfast items of the south India,usually prepared in a short period of time with wheat semolina.Generally, it is prepared afresh every time and depends upon the quantity it takes about 15-25 min(Balasubramanianet al., 2012).

Millets are the underutilised category of cereal grains. But in the recent years, millets have become an important component of several processed foods due its potential nutritional and functional properties. Millets are good sources of protein, energy, carbohydrate, dietary fiber, calcium, iron and also rich source of phytochemicals. Presence of these nutrients and phytonutrients helps in the prevention of diet induced metabolic disorders (Himanshuet al., 2018). Minor millets include proso, barnyard, little, and kodo milletare used as an essential ingredient in the preparation of several multigrain and gluten free cereal based products, various traditional foods and beverages (Upadhyaya *et al.*, 2016). These millets have unique superior health benefits. Minor millets are abundant source of vitamins, dietary fiber, micronutrients and other bioactive compounds like tannins, polyphenols and flavonoids (Ranaet al., 2023).

Semolina made from minor millets could be a novel product that can provide natural health benefits of minor milletsto the consumers. Additionally, it adds dietary diversity and also allowsnew ways of utilisation of minor millet. Till now widespread utilisation of minor millets was limited, owing to the lack of availability of various types of foods in the market. As minor millets are free from gluten protein and so semolina from them can be used in place of wheat semolina, which would be useful to the individuals who are intolerant to wheat protein (Tharaand Nazni, 2021). Many of thestudied focused on the value addition of major millets whereas up to now no one has developed minor millets like kodo, proso, little and barnyard millet based instant upma mixes. With all these considerations, the goal of this study is to develop a ready-to-cook (RTC) upma mix and to assess its sensory and chemical composition to improve the nutritional quality of the breakfast component.

Materials and methods:

The present study was conducted at Millets Processing and Incubation Center, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyerabad (India).

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Processing of millets: The four millets such as Proso, barnyard, little, and kodo millets were exposed to rotary drying to obtain the required amount of moisture (less than 12%). Then the selected grains were given different treatments like soaking, autoclaving (10 min at 15 PS) and roasting to select the best treatment for the instant upma mix production. The vegetables

like beans, carrot, green chilies and onions were cut into small pieces and blanched for 1 min at 100▪ C, tray dried at 60▪ C and stored in air tight container till use.

Process description of minor millet based instant upma mixes: Firstly, all the required ingredients including treated grain, dried vegetables and other spices were weighed separately (Table-1). Add oil, pre weighed mustard seeds, black gram, Bengal gram to the pan and wait till they splutter. Then add jeera, treated grain and roast them followed by addition of dried vegetables and mix them properly to get uniform flavour. Then cool and pack in airtight LDPE pouches for further analysis.

Table-1: Formulation of instant minor millet based instant upma mix (g/100g)

Ingredients	Quantity	Ingredients	Quantity
Treated Millet grain	68.0	Ginger powder	0.50
Black gram	5.00	Salt	3.25
Bengal gram	5.00	Green chilli	1.75
Mustard	3.00	Onion(dried)	5.00
Beans	3.00	Curry leaves	0.50
Carrot	3.00	Jeera	0.2

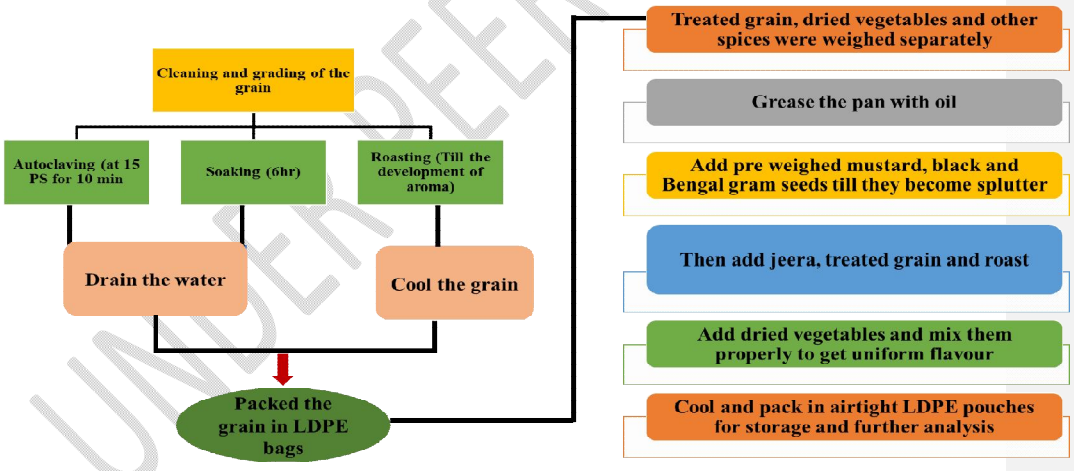

Figure-1: Flow chart of minor millet based ready to cookupma mix

Sensory evaluation of the developed products:

Instant upma mixes were prepared by boiling 2.5 cups of water and adding 25gm of upma mix, cooking on low flame till desired consistency and were subjected to sensory evaluation using 9- point hedonic scale (Meilgaard *et al.*, 1999) with semi trained panel members for selecting best formulation from each millet. Acceptability index was calculated by totalingup

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of all the sensory scores of appearances, texture, flavour, taste and overall acceptability and it was divided by maximum score and multiplied by 100.

Acceptability index = total scores/maximum scores*100

Cooking parameters: Cooking parameters like water uptake, cooking time, weight of cooked product and rehydration ratio was assessed by standard procedures (Sharma *et al*., 2022).

Comment [WU5]: Add formula of cooking parameters

Nutritional and phytonutrient composition of the developed products: Moisture, ash, protein (AOAC, 2005), fat (AOAC, 1997), crude fiber(AOAC, 1995), carbohydrate and energy (AOAC, 1980) and minerals like calcium, iron, zinc, sodium, phosphorus and magnesium were analyzed by the standard procedures (AOAC, 2012). Phytonutrients like total phenols (Slinkard and Slingleton, 1997), antioxidant activity by DPPH (Tadhani*et al*., 2007), tannins (AOAC, 2005) were analyzed.

Comment [WU6]: Add formulas

Storage studies: The sensorially best selected formulation was stored in polypropylenepouchesandstoredatambienttemperatureforshelf-life studies. During storage, moisture (AOAC, 2005), Total Bacterial Count (TBC) and Total Mould Count (TMC) (Tambekar*et al.,* 2009) were analyzed on 30th, 60th, 90th and 120th day of storage.

Statistical analysis: All experiments were performed three times. All data were presented as mean ± standard deviation. The means were compared using the least significant difference (LSD) at 5% level.

Results and discussion

Sensory evaluation of instant upma mixes:

The obtained scores for sensory attributes like colour, taste, texture, flavour and overall acceptability of three differently (soaking, roasting and autoclaving) treated four (kodo, proso, little and barnyard millet) minor millets based RTC (Ready to cook) instant upma mixes were given in Table 2.The study found that among the kodo millet based upma mixes, there was significant difference was found between the sensory attributes like colour, taste and overall acceptability whereas texture and flavour scores were similar. In case of proso millet based upma mixes, scores showed that the selected treatment have no effect on the colour, flavour and overall acceptability. But taste (7.80), texture (8.10) and acceptability index (82.2) of roasted proso instant upma mix (RPUM) was scored high than other treatments. Among the little millet based upma mixes, roasted little millet based upma mix

showed high scores for colour, flavour and acceptability index. Significant difference ($p \leq 0.05$) was found in the sensory attributes for barnyard millet upma mixes except for texture. Overall, the results of the study found that among the three treatments, roasted minor millet based upma mixes scored high in all sensory attributes and have high acceptability index. Therefore,RKUM (Roasted kodo millet based instant upma mix), RPUM (Roasted proso millet based instant upma mix), RLUM (Roasted little millet based instant upma mix)and RBUM (Roasted barnyard millet based instant upma mix) was selected for the further study.

Table-2: Mean sensory scores of developed instant upma mixes

Kodo millet based instant upma mixes						
Samples	**Colour**	**Taste**	**Texture**	**Flavour**	**Overall acceptability**	**Acceptability index**
RKUM	7.5a±0.85	7.90a±0.87	7.80a±1.03	7.40a±0.97	7.60a±0.69	84.9
SKUM	6.80ab±0.79	6.80b±0.92	7.20a±0.63	7.10a±0.99	6.70a±0.67	76.9
AKUM	6.40b±0.97	6.90b±0.99	7.00a±0.81	6.80a±0.63	6.90ab±0.87	75.6
F-Value	4.08	4.27	2.44	1.16	3.92	
p-value	0.03*	0.02*	0.11NS	0.33NS	0.03*	
Proso millet based instant upma mixes						
RPUM	7.20a±0.92	7.80a±1.03	8.10a±0.87	6.80a±1.54	7.10a±1.45	82.2
SPUM	6.30a±1.25	5.80b±1.22	6.40b±0.84	6.5a±0.85	6.30a±0.95	69.6
APUM	6.50a±0.97	6.10b±0.74	7.00b±0.67	6.10a±1.19	6.20a±1.47	70.9
F-Value	1.99	11.17	11.60	0.81	1.41	
p-value	1.55NS	0.00**	0.00**	0.45NS	0.26NS	
Little millet based instant upma mixes						
RLKM	8.20a±0.78	7.30a±0.95	7.10a±1.28	7.50a±0.97	7.20a±1.13	82.9
SLKM	6.70b±1.34	6.60a±1.43	7.00a±1.15	6.80ab±1.47	6.90ab±0.87	75.6
ALKM	6.60b±0.97	6.40a±0.84	6.90a±0.87	6.00b±1.15	6.00b±1.33	70.9
F-Value	7.21	1.83	0.08	3.79	3.05	
p-value	0.00**	0.18NS	0.92NS	0.03*	0.06NS	
Barnyard millet based instant upma mixes						
RBKM	7.80a±0.92	8.10a±0.74	7.80a±1.03	8.10a±0.74	7.90a±0.99	88.2
SBKM	7.00ab±0.82	7.30a±1.25	7.60a±0.96	7.30ab±0.94	7.10ab±1.19	81.1
ABKM	6.60b±0.97	6.20b±1.31	7.10a±1.19	6.40b±0.97	6.50b±1.26	72.9
F-Value	4.28	7.10	1.14	9.12	3.67	
p-value	0.02*	0.00**	0.34NS	0.00**	0.03*	

Note: The values are presented as the mean±SD of (n=15) replications. SEM-Standard error mean, CD-Critical Difference, NS-non-significant, *Significant at 5%, **Significant at 1%. Values with a different superscript in the same column are significantly different ($p \leq 0.05$).

RKUM: Roasted kodo millet based khichdi mix
SKUM: Soaked kodo millet based khichdi mix
RLUM: Roasted little millet based khichdi mix
SLUM: Soaked little millet based khichdi mix

AKUM: Autoclaved kodo milletbased khichdi mix

APUM: Autoclaved little millet based khichdi mix

RPUM: Roasted proso millet based khichdi mix

RBUM: Roasted little millet based khichdi mix

SPUM: Soaked proso millet based khichdi mix

SBUM: Soaked little millet based khichdi mix

APUM: Autoclaved prosomillet-based khichdi mix

ABUM: Autoclaved little millet based khichdi mix

Cooking Parameters: The selected upma mixes were analysed for the cooking parameters such as water uptake, cooking time and rehydration capacity. Cooking time cooked weight of RKUM, RPUM, RLUM and RBUM was 11 min &138g, 12 min & 128 gm, 14 min & 160 gm and 15 and 170 gm respectively. Rehydration ratio (RR) is a measure of water absorption by the dehydrated product, rehydration ratio of RKUM, RPUM, RLUM and RBUM was 5.52, 5.12,6.40 and 6.80 respectively. The results of the study showed that RBUM showed high water uptake (240ml/25gm), high cooking time (15min), high cooked weight (170gm) and high rehydration ratio (6.8) whereas PMUM has low cooked (128gm) and rehydration ratio (5.12).

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Nutritional composition of instant upma mixes: The nutritional composition of developed upma mixes were given in Table-3. There was significant difference was observed in the moisture, fat, protein, energy, total and available carbohydrate content of developed instant upma mixes. Moisture content of RKUM, RPUM, RLUM and RBUM was 8.80%, 9.47%, 7.89% and 7.16% respectively. Ascending order of protein content of instant mixes were RKUM (6.26%) < RBUM (6.89%) < RLUM (7.87%) < RPUM (10.68%). Among the four products, highest moisture (9.47%) ash (5.14%) and protein (10.68%) content was found in RPUM. RLUM found high energy (373.70Kcal), total carbohydrate (76%) and available carbohydrate (74.61%). High fat content was observed in RKUM (6.47%) whereas RLUM scored lowest (4.86%). Crude fiber content of all the developed product was almost similar and no significant difference was observed between them.

Human are essential micronutrients to the body, as body unable to generate its own minerals. They are vital for the normal and healthy functioning of the body. Among all the minerals, iron and zinc are the major global concerns of public health (Shankar, 2013).Mineral content of instant upma mixes were analysed and reported in Table-4. Minerals like iron, zinc and phosphorus content of developed products was ranged between 7.32mg/100g (RPUM)-11.28mg/100g (RKUM), 3.65mg/100g (RLUM)-5.73mg /100g (RPUM) and 490.0mg/100g (RLUM)-583.33mg/g (RPUM) respectively. Among the developed products, highest zinc and phosphorus content was found in RPUM whereas

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highest iron content was seen in RKUM (11.28mg/100gm). The total mineral content of foxtail, little and barnyard millet was higher than commonly consumed cereals. The iron content of barnyard and little millet was very high 9-12% (Himanshu*et al.*, 2018). High iron content of these minerals significantly increased the iron content of instant upma mixes.

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Phytonutrients are the plant secondary metabolites having protective effects against degenerative diseases. Millets are rich sources of phytochemicalsand antioxidants, such as phenolic acids and flavonoids (Stanly and Shanmugam, 2013; Tharaand Nazni, 2021). Development of instant upma mixes with minor millets significantly increased the phytonutrient content. Total phenol, tannin and antioxidant activity of developed products was ranged between 1.98mg GAE/100g-6.07mg GAE/100g, 0.45mg TAE/100g-0.58mg TAE/100g and 9.10%-25.58% respectively. The results of the study found that total phenol and tannin content of RLUM was high whereas highest antioxidant activity was seen in RKUM.

Storage stability of developed instant upma mixes: Shelf life of any food product is altered due to lipid peroxidation and enzymatic hydrolysis. Autooxidation of fats and oils is the major limiting factor that influences the shelf life of dehydrated instant mixes (Semwal et al. 1999; Balasubramanian et al., 2012). Developed minor millet based instant upma mixes were stored in airtight LDPE pouches at ambient conditions (20–35 °C) and continuously monitored for moisture content, TBC and TMC content during storage (Table-5). Increase in moisture content and microbial load of all the products was observed during the storage period 0-120th day. Overall, the study found that all the developed instant upma mixes can be stored upto 90 days at ambient temperatures.

Table-3: Nutritional composition of instant upma mix

Sample	Moisture (%)	Fat (%)	Protein(%)	Crude fibre (%)	Ash (%)	Total carbohydrate (%)	Available carbohydrate (%)	Energy (kcal)
RKUM	8.80±0.32^{b}	6.47±0.56^{a}	6.26±0.10^{d}	1.50±0.63^{a}	4.27±1.06^{ab}	74.21±1.64^{b}	72.71±0.01^{c}	374.08±1.91^{a}
RPUM	9.47±0.22^{a}	5.41±0.61^{b}	10.68±0.10^{a}	1.80±0.85^{a}	5.14±0.08^{a}	69.29±0.73^{c}	67.49±1.50^{d}	361.41±1.43^{b}
RLUM	7.89±0.21^{c}	4.86±0.19^{b}	7.87±0.10^{b}	1.39±0.16^{a}	3.37±0.22^{b}	76.00±0.14^{a}	74.61±0.08^{a}	373.70±1.75^{a}
RBUM	7.16±0.06^{d}	5.41±0.34^{b}	6.89±0.14^{c}	2.42±0.10^{a}	4.07±0.07^{b}	76.46±0.45^{a}	74.04±0.54^{ab}	372.45±1.52^{a}
F-Value	63.49	6.43	900.51	2.24	5.44	37.42	35.39	39.62
SEM	1.01	0.67	1.95	0.46	0.73	3.28	3.25	6.04
CD	4.56**	3.02*	8.79**	NS	3.05*	14.76**	14.61**	27.18**

Table-4:Antioxidants and mineral composition of instant upma mix

Sample	Total Phenols (mg GAE)	Tannins(mg TAE)	Antioxidant activity (%)	Iron(mg/100g)	Zinc(mg/100g)	Phosphorus(mg/100g)
RKUM	4.17±0.03^{b}	0.45±0.03^{b}	25.58±0.08^{a}	11.28±0.01^{a}	4.76±0.01^{b}	580.00±100.00^{a}
RPUM	3.28±0.04^{c}	0.46±0.03^{b}	11.42±0.43^{c}	7.32±0.01^{d}	5.73±0.01^{a}	583.33±15.28^{a}
RLUM	6.07±0.05^{a}	0.58±0.01^{a}	9.10±0.08^{d}	8.49±0.01^{b}	3.65±0.01^{d}	490.00±100.00^{a}
RBUM	1.98±0.21^{d}	0.46±0.03^{b}	17.05±0.05^{b}	7.77±0.01^{c}	4.57±0.77^{c}	493.33±20.82^{a}
F-Value	709.14	17.24	3221.11	94832.45	21832.59	1.57
SEM	1.71	7.33	0.06	1.78	0.85	52.00
CD	7.72**	33.00**	0.27**	8.00**	3.84**	NS

Note: The values are presented as the mean±SD of three replications. SEM-Standard error mean, CD-Critical Difference, NS-non-significant,

**Significant at 1%. Values with a different superscript in the same column are significant.

RKUM: Roasted kodo millet based instant upma mix
RPUM: Roasted proso millet based instant upma mix
RLUM: Roasted little millet based instant upma mix
RBUM: Roasted barnyard millet based instant upma mix

Table-5: Microbial studies of Instant Upma Mix

Variety name	Kodo millet upma mix			Proso millet upma mix			Little millet upma mix			Barnyard millet upma mix		
Duration	Moisture (%)	TBC (Cfu/ml) 10^{-5}	TMC (Cfu/ml) 10^{-5}	Moisture (%)	TBC (Cfu/ml) 10^{-5}	TMC (Cfu/ml) 10^{-5}	Moisture (%)	TBC (Cfu/ml) 10^{-5}	TMC (Cfu/ml) 10^{-5}	Moisture (%)	TBC (Cfu/ml) 10^{-5}	TMC (Cfu/ml) 10^{-5}
0th Day	7.69	11	ND	6.87	4	ND	7.01	17	ND	7.21	17	ND
30th Day	8.22	17	ND	6.93	11	ND	7.22	23	ND	7.87	27	ND
60th day	8.63	27	ND	7.15	26	ND	8.10	27	ND	7.96	36	ND
90th day	9.07	30	2	7.41	33	ND	8.66	34	ND	8.42	47	ND
120th day	9.88	42	4	7.93	41	8	9.11	40	3	9.23	59	7

Note: The values are presented as cfu per ml of the batter. TBC: Total bacterial count, TMC: Total mold count, ND: not detected.
Note: The values are presented as the mean±SD of three replications. SEM-Standard error mean, CD-Critical Difference, NS-non-significant,

**Significant at 1%. Values with a different superscript in the same column are significant.

RKUM: Roasted kodo millet based instant upma mix
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RBUM: Roasted barnyard millet based instant upma mix

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Conclusion: Millets have played a vital role in the standardisation and development of modern meals such as multigrain and gluten-free cereals. The finding of the study determined that minor millet based instant upma mixes have good sensory, nutritional and phytonutrient properties. Being a good source of energy, protein, minerals and phytonutrients, these products can be included in the mid-day meal or other feeding programmes could add dietary diversification, increases the minor millets utilisation in the market.

Comment [WU11]: Add some point from above research findings.

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Comment [WU12]: Rearrange alphabetically

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AOAC, Official Methods of Analysis for ash in flour. *Association of Official Analytical chemists*, (2005a).

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